

021278

Final Report

"Life Sciences Data Archive Scientific Development."
Contract NAS 9-19190

Submitted by:

Jay C. Buckey, Jr., M.D.
Associate Professor of Medicine
University of Texas-Southwestern Medical Center

Abstract: The Life Sciences Data Archive will provide scientists, managers and the general public with access to biomedical data collected before, during and after spaceflight. These data are often irreplaceable and represent a major resource from the space program. For these data to be useful, however, they must be presented with enough supporting information, description and detail so that an interested scientist can understand how, when and why the data were collected. The goal of this contract was to provide a scientific consultant to the archival effort at the NASA-Johnson Space Center. This consultant (Jay C. Buckey, Jr., M.D.) is a scientist, who was a co-investigator on both the Spacelab Life Sciences-1 and Spacelab Life Sciences-2 flights. In addition he was an alternate payload specialist for the Spacelab Life Sciences-2 flight. In this role he trained on all the experiments on the flight and so was familiar with the protocols, hardware and goals of all the experiments on the flight. Many of these experiments were flown on both SLS-1 and SLS-2. This background was useful for the archive, since the first mission to be archived was Spacelab Life Sciences-1. Dr. Buckey worked directly with the archive effort to ensure that the parameters, scientific descriptions, protocols and data sets were accurate and useful.

INTRODUCTION

The data from spaceflight experiments is valuable and often irreplaceable. One of the goals of NASA is provide the widest practicable distribution for spaceflight data. Biomedical data are critical for establishing normative physiologic changes in space and for understanding gravity related changes. Data collected over several missions can be combined into meta analyses, and data from one discipline (e.g. cardiovascular physiology) can be combined with data from another discipline (e.g. fluid and electrolyte metabolism) to get an integrated understanding of spaceflight-induced physiologic changes. To do these analyses, however, scientists must have access to the key data, and they must be able to understand how the data were collected. The Life Sciences Data Archive is being constructed to allow for the greatest benefit to be gained from NASA's investment in space biomedical research.

Building a truly useful archive, however, is an challenging task. Scientific Shuttle missions were not necessarily designed with ultimate archival in mind. These missions have a variety of different experiments on them and each experiment has a different investigator team. Each team may have different data formats, procedures etc. Also, the time between when an experiment was proposed and flown can be quite long. During this time, experiments can change with the addition or deletion of objectives, protocols, parameters and hardware. These changes may not be accurately reflected in the archived documentation. An observer not directly involved with the history and development of a mission might find it very difficult, if not impossible, to reconstruct exactly what took place.

Also, archiving of biomedical data differs in one key aspect from data collected as part of astronomy or planetary investigations. In those investigations the focus is clearly on data collected in space. For biomedical investigations, the data collected before and after the flight is often as, or more, important than the inflight data. Most archived documentation, however, is concerned with the actual flight, (i.e. in flight procedures, flight hardware, in flight sessions), and documentation on the critical pre and post flight sessions can be lacking or incomplete.

To help resolve these problems, the manager of the Johnson Space Center Data Archive (Jeffery A. Cardenas) identified the need for someone who was familiar with scientific shuttle missions and could help make the archive usable for the scientific community. Jay C. Buckey, M.D. from the University of Texas-Southwestern Medical Center was put under contract to provide for the scientific development of the Life Sciences Data Archive. The goal was to assist with the development of the prototype archive, which was focused on the Spacelab Life Sciences-1 mission.

AREAS OF WORK

Parameters Measured

The heart of any archive is the data itself. The individual investigators have the data and must send it to the archive to be entered. Before requesting data, however, the archive must have a clear idea of what data to expect. Without an accurate and complete listing of the data from a given mission, the archive would have no way to evaluate the completeness of the archival.

Prior to requesting data, the archive made a listing for each experiment of the actual data collected. This was made from a variety of sources e.g. the experiment documents, the data sharing plan, crew training manuals, and published papers. There was no single reliable source for this information.

Recommendation

For future flights include a reliable parameters measured list in the experiment document (or other appropriate document) and insure that it is updated immediately after the experiment is completed. All pre and post flight parameters measured must also be included.

Protocols

Most of the human experiments included formalized data collection sessions. These usually followed a defined protocol. The actual protocols used, however, had to be pieced together from different sources e.g. the mission science requirements document, flight procedures, HRPPC

submittals, and experiment documents. As with the parameters measured, no reliable, single source for this information existed.

Recommendation

For future flights, require that each experiment provide a detailed protocol for each measurement session and keep these protocols in one document (the mission science requirements document is one possibility). This document should be updated frequently, but must be updated right after the flight to insure that it accurately reflects what was actually done.

Hardware Descriptions

The goal of the archive is provide information about methodology at a level comparable to the "methods" section in a peer-reviewed journal. To accomplish this, information about hardware used pre and post flight as well as inflight must be included. Currently, volumes of information is available about flight hardware, but information about pre and post flight hardware is spotty. Information for this section was compiled from NASA documents, published papers, HRPPC submittals, and crew training manuals.

Recommendation

Communicate to the investigators that their data needs to be archived along with information on the methodology comparable to what would be required in a peer-reviewed journal. This equipment information should be kept in one document (the experiment document is one choice) and should be reviewed after the flight.

Experiment descriptions

Whenever possible the most recent description in the P.I.'s own words was used.

Data Privacy

Data were entered and the archive has been constructed based on the assumption that data for individuals (not identified by name) will be presented. In other words, the assumption is that the archive will contain all the data for each person studied and not just summarized or averaged data. If this is not the case, the prototype will require extensive modification, and the usefulness of the archive will be limited.

Recommendation

There is no more important issue to the archive than a resolution of how the privacy of the data in the system will be handled. This should be the top priority issue.

Archive Development

Throughout the development process the scientific consultant was located in the same room as the developers and this was very beneficial to both parties. Issues could be discussed and resolved easily and new approaches could be tested quickly. This approach to the scientific inputs should be extended to the usability evaluation of the archive. The developers need to observe the evaluation and have quick access to usability experts.

Recommendation

Use the usability expertise and resources at Johnson Space Center to provide for rapid feedback from evaluations to the developers.

National Space Science Data Center (NSSDC) Home Page

Descriptions of the experiments were written for the NSSDC internet home page. This page has recently gone on line and can be accessed by the general public.

Recommendation

Continue to place as much descriptive information on line as possible. The goal should be to get the master LSDA catalog on line as soon as possible. This is the best way to inform people about the work that has taken place at NASA.

OTHER ACCOMPLISHMENTS

The archive was presented at the AIAA Life Sciences in Space Meeting held in Houston. The publication resulting from this is included.